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A Comparison of Stress Responses in Sea Urchins and Sea Cucumbers Exposed to Salinity and Handling Stress

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A COMPARISON OF STRESS RESPONSES IN SEA URCHINS AND SEA CUCUMBERS EXPOSED TO SALINITY AND HANDLING STRESS

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Introduction

- Sea urchins are echinoderms that are generating interest in aquaculture
- Sea urchins are particularly valuable as:
  - Research models
  - Delicacy food item
- Many sea urchin populations have been greatly overfished
  - Depletion of European and Asian stocks has reduced sea urchin quality

Photo by Navid Ayon

Bertocci et. al. 2014; Botsford et. a. 2004

Introduction

- Animals can be raised in aquaculture conditions
  - Prevents:
    - Overfishing
    - Pollutant contamination
    - Loss to predation
    - Low quality product
    - Damage to ecosystem
- However, organisms encounter stress in intensive aquaculture environments
    - Some species are hardier than others
    - Hardy species make better aquaculture candidates
      - More resistant to disease
      - Better production
      - Easier to raise

Research Objectives

- To compare the stress responses of echinoderms in conditions that might be encountered in an aquaculture environment.
  - Handling
    - Animals are moved from tank to tank
    - In research facilities, they must be handled for sampling
  - Salinity change
    - Rain water can dilute salinity of culture ponds
    - Purchasing ocean mimicking salt mixes is expensive

Photo by Navid Ayon

Materials and Methods

- Adult purple sea urchins (*Stronglyocentrotus purpurtus*) and giant California sea cucumbers (*Parastichopus californicus*) were obtained from Bodega Marine Laboratory Station in Bodega Bay, California.
- Three treatment groups were established
  - Handling
    - Three times daily for 5 minutes; kept at optimal salinity (34 ppt)
  - Low salinity
    - Kept at 28 ppt
  - Controls
    - Optimal salinity (34 ppt) and never handled
- After 72 hours in treatment conditions, coelomic fluid was collected for analyses of cells (coelomocytes)

Materials and Methods

- Coelomocytes were counted via hemocytometer for differential and total coelomocyte count (Braak, 2002)
- Total protein content was read via protein refractometer (Mustafa et. al. 2000)
- Lytic activity was determined by lysozyme turbidity assay (Chia & Xing, 1996)

Photo by Tazin Fahmi

(Braak 2002; Chia & Xing 1996; Mustafa et. al. 2000)

Material and Methods

- Phagocytic capacity of cells was determined by counting cells with engulfed bacteria (formalin-killed) bacteria (Mustafa et. al. 2000)
- Respiratory burst activity was determined by spectrophotometer

$$\text{Phagocytic capacity} = \frac{\text{Number of cells with engulfed bacteria}}{\text{Total number of cells}} \times 100$$

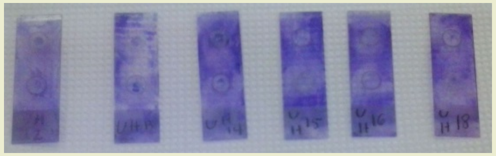


Photo by Stacy Keough

Coelomocyte Studies

- Changes in coelomocytes
  - Total and differential sea urchin cell count
    - Phagocytic
    - White spherule
    - Red spherule
    - Vibratile
  - Coelomic fluid protein
  - Phagocytic capacity
  - Lytic activity

(Smith et. al. 2010)

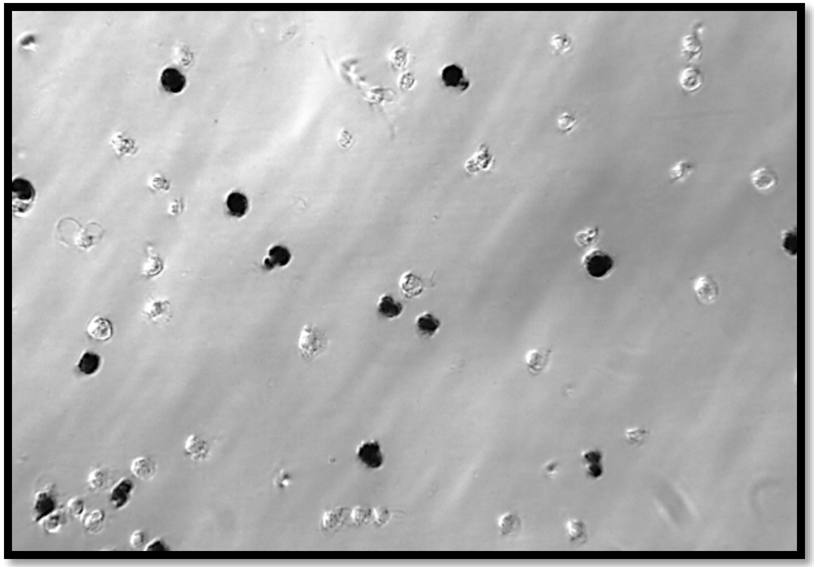


Photo by Regina Shannon

Sea Urchin Cells

(Smith et. al. 2010)

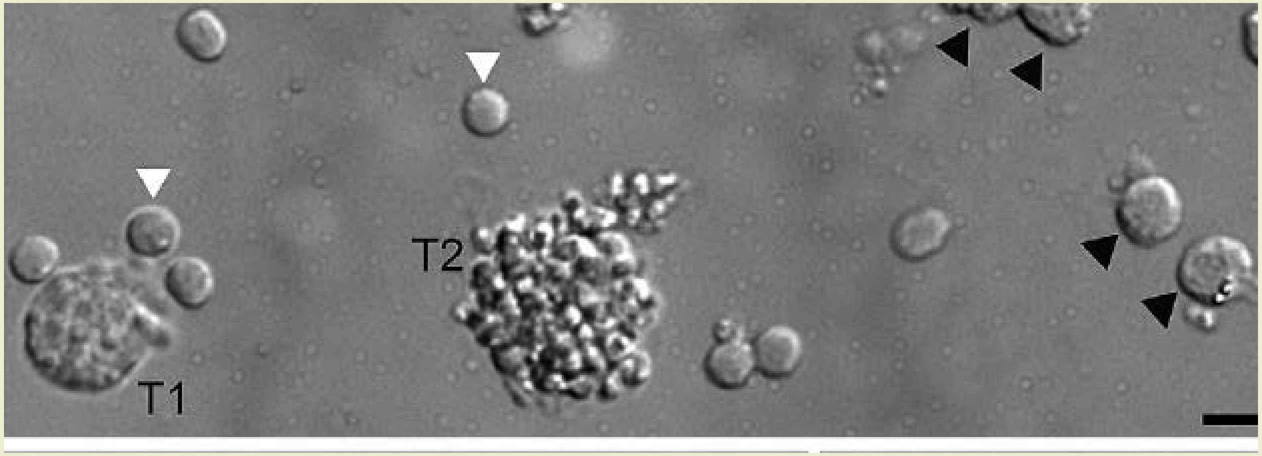
Types of Sea Urchin Cells

Photo by Regina Shannon

Sea urchin cell types

- A—White spherule cell
- B—Vibratile cell
- C—Phagocytic cell
- D—Red spherule cell

Types of Sea Cucumber Cells



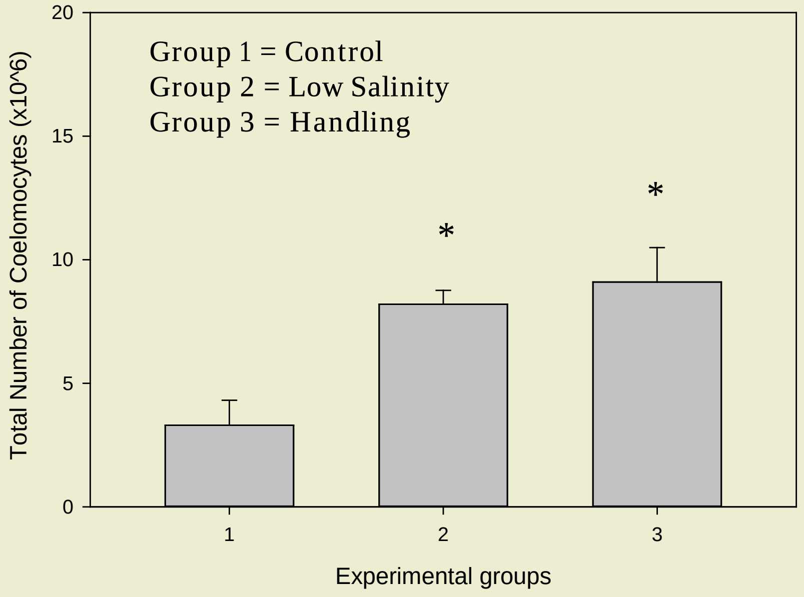
Sea cucumber cell types

A—Lymphocyte
B—Type 1 and Type 2 spherule cell
C—Phagocytic cell

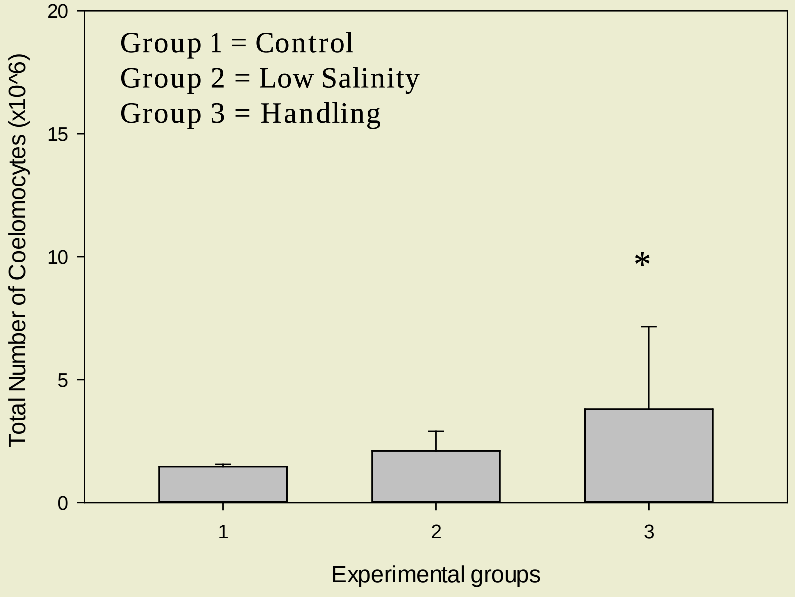
Results: Total Coelomocyte Count

Total Coelomocyte Count

Sea Urchin



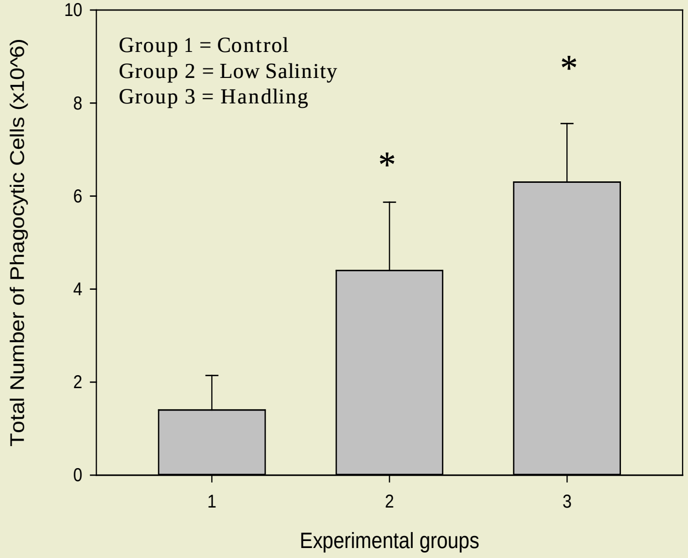
Sea Cucumber



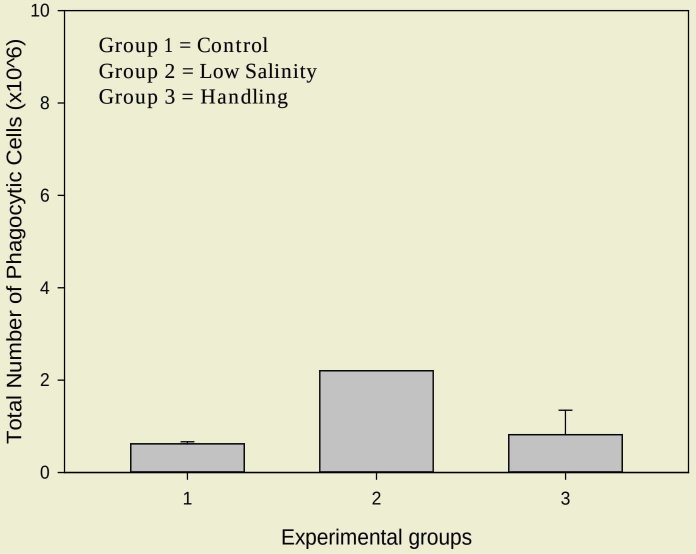
Results: Differential Cell Counts

Number of Phagocytic Cells

Sea Urchin

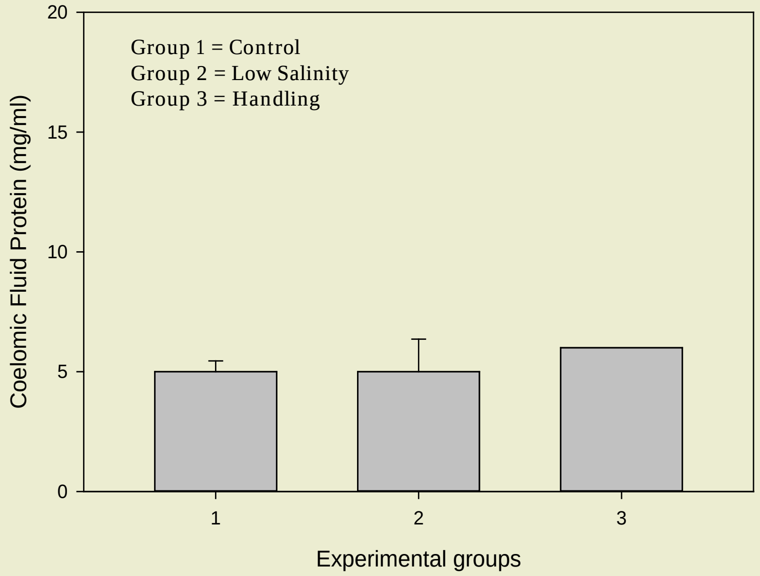


Sea Cucumber

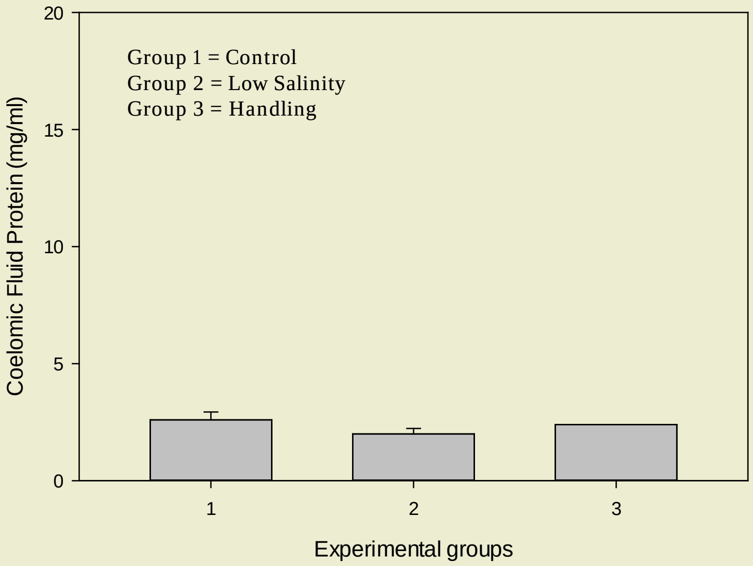


Results: Coelomic Fluid Protein

Sea Urchin



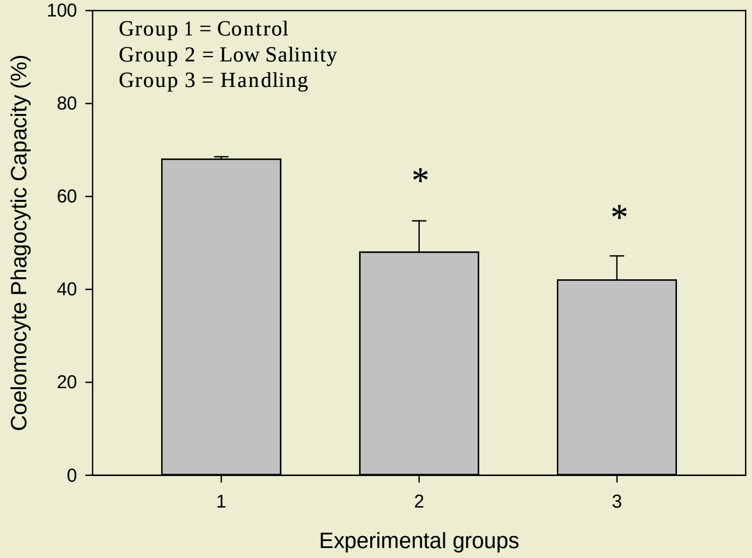
Sea Cucumber



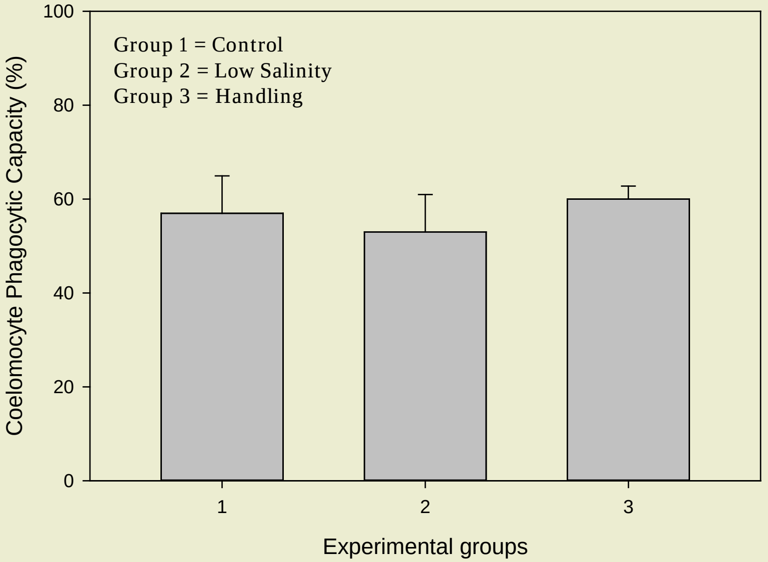
Results: Phagocytic Capacity

Phagocytic Capacity of Phagocytic Cells

Sea Urchin



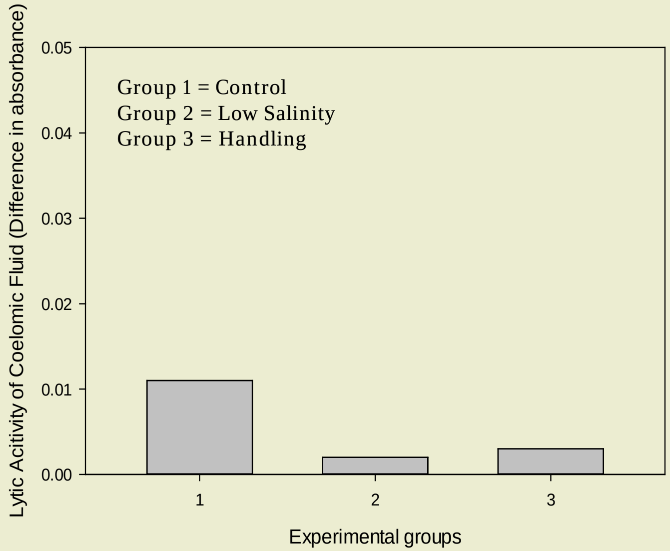
Sea Cucumber



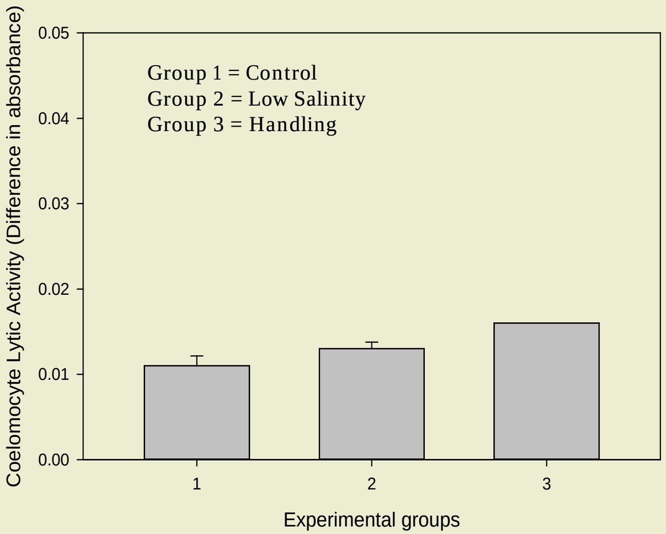
Results: Lytic Activity

Lytic Activity of Coelomic Fluid

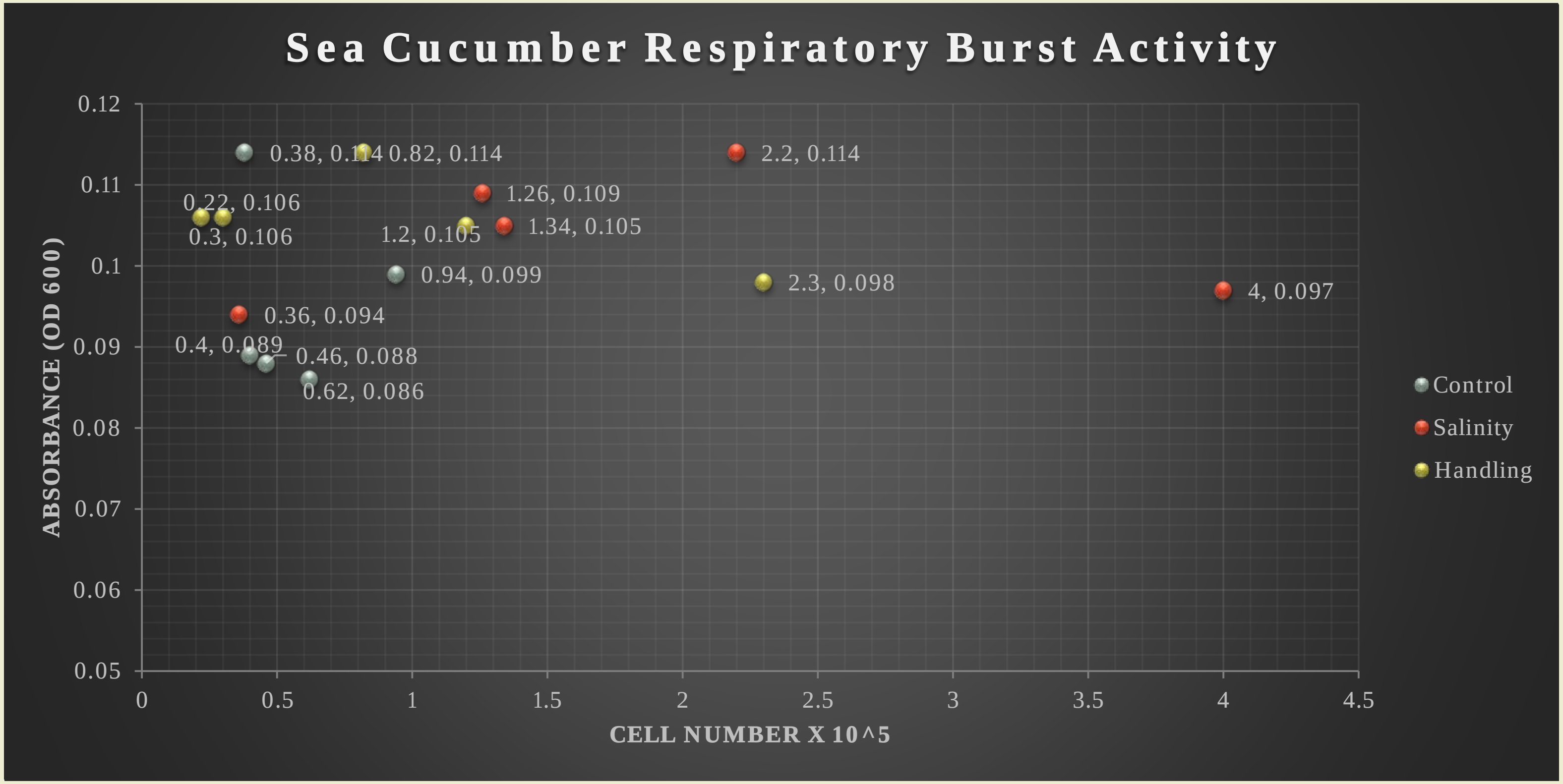
Sea Urchin



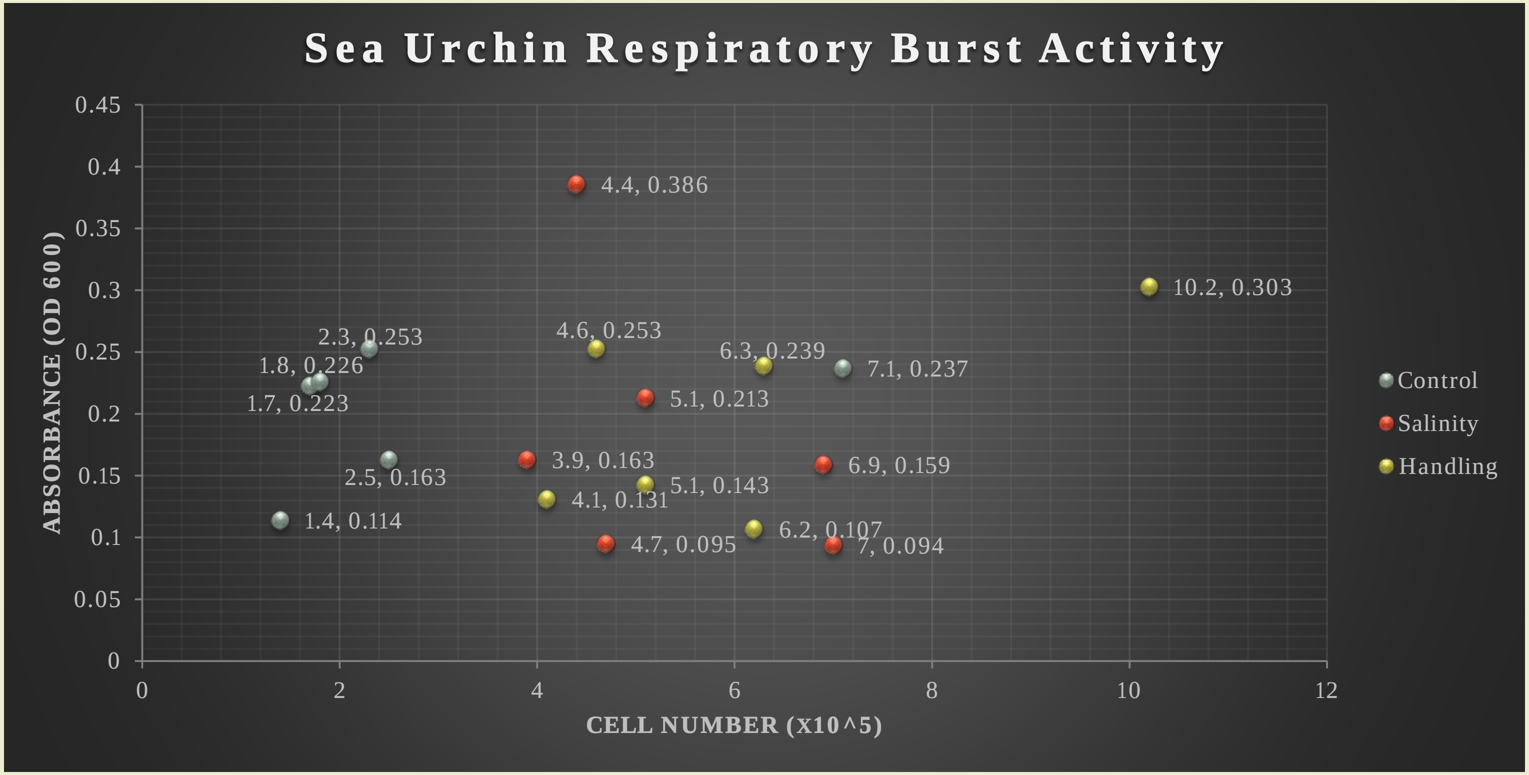
Sea Cucumber



Results: Respiratory Burst Activity



Results: Respiratory Burst Activity



Conclusion

- It appears that both handling and low salinity produce significant stress responses in sea urchins, though not significant stress in sea cucumbers.
- This would indicate that sea cucumbers are a hardier aquaculture candidate than sea urchins.

Photo by Stephen Shannon

Impact

- Our study of the physiological and immunological parameters in invertebrate aquaculture can be used for increased production and to make better pharmaceuticals in the future.
- An increase in culturing these species will help reduce the risk of overfishing.
- Intensive aquaculture will prevent problems associated with off-show culturing.

Further Research

- Areas for further research include:
  - Effects of varying salinities on animal health
  - Longer term study
  - Studies utilizing the impact of nutraceuticals on animal immune function

Photo by Tazin Fahmi

Acknowledgments

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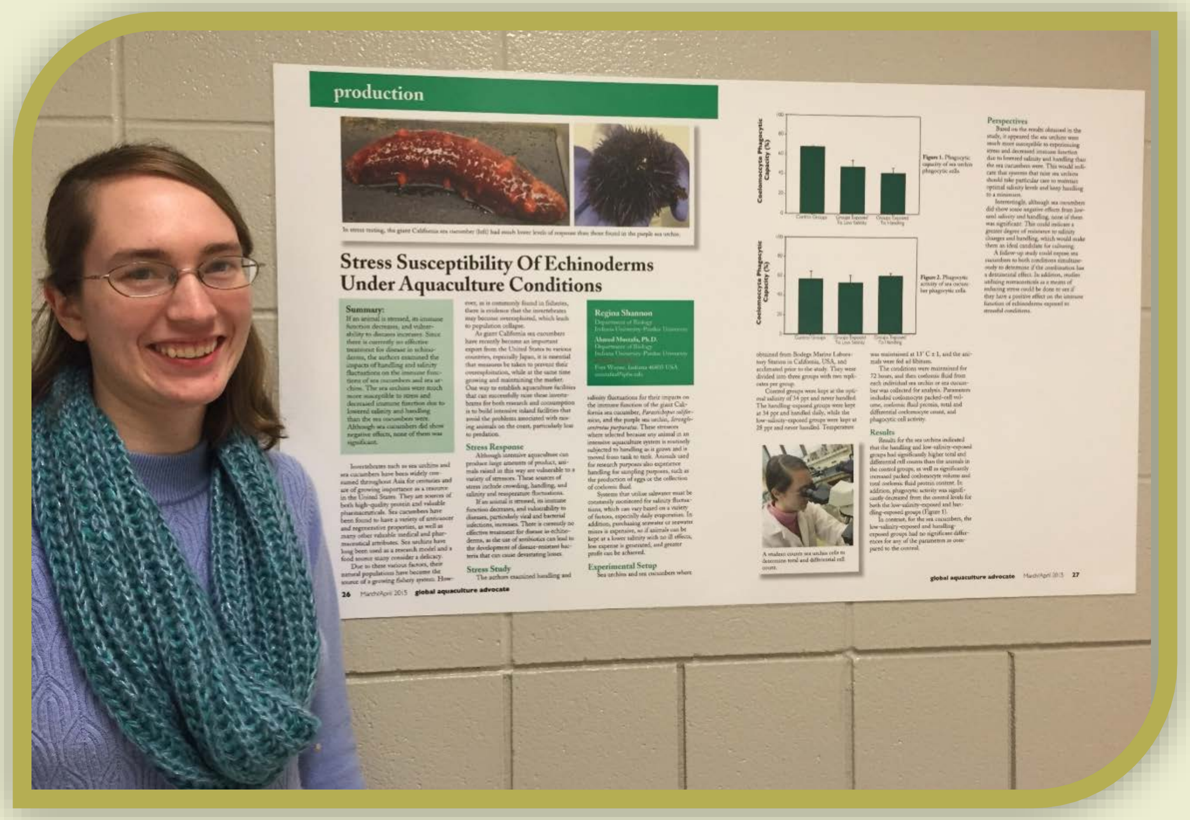
Questions?


production
Stress Susceptibility Of Echinoderms Under Aquaculture Conditions
Summary:
Stress Response
Stress Study
Experimental Setup
Results
Perspectives